Consulting Analytical Chemists and Geochemists

LEVEL OF SIGNIFICANCE AND CONFIDENCE AND TYPE 1 AND 2 ERRORS

Allan Fraser

October 2020

Applications Note: 37

How confident are we of our decision to reject or accept the Null Hypothesis? This confidence is expressed as the Level of Confidence (LOC). An LOC, typically 95% is used in chemical analysis. At 95% LOC we are 95% certain that we made the correct decision of accepting the Null Hypothesis with 5% chance we made the incorrect decision.

The level of significance (α) can be expressed as level of confidence (LOC):

$$LOC = 100(1 - \alpha)\% \qquad [1]$$

Therefore, if α is at 5%, or, expressed as a fraction, 0.05, then the LOC is:

$$LOC = 100(1 - 0.05)\% = 95\%$$

It is also important to consider that if we reject H_0 and it is actually true, and conversely if H_0 is false and we do not reject it, that we have introduce a Type 1 and Type II error, respectively. Therefore:

Type I Error = α (Alpha) Error = *False Positive* = If we reject H_0 and H_0 is actually true.
Type II Error = β (Beta) Error = *False Negative* = If H_0 is false but we fail to reject it.

Table 1. Type I and Type II Errors.

		Null hypothesis (H_0) is:	
		TRUE	**FALSE**
Judgement of Null Hypothesis (H_0)	**Reject**	Type I error *(False Positive)*	Correct inference *(True Positive)*
	Fail to reject (accept)	Correct inference *(True Negative)*	Type II error *(False negative)*

Typically, when we try to *decrease* the probability one type of error, the probability for the other type increases. We could decrease the value of alpha from 0.05 to 0.01, corresponding to a 99% level of confidence. However, this would increase the risk of rejecting the null when it is in fact true, even though we have greater confidence in accepting the null hypothesis.

Imagine increasing the α level to 0.35. This increases the chance of rejecting the null hypothesis. The risk of a **Type II error** (false negative) is reduced. But the risk of a **Type I error** (false positive) is increased.

If you decide to decrease the α level to 0.01, this would, increase the chance of *accepting* the null hypothesis, with the risk of a **Type I error** (false positive) is reduced, but the risk of a **Type II error** (false negative) is increased.

Therefore, the α level of 0.05 represents the best equilibrium to avoid excessive type I or type II errors.

Reference:

Ellison, S., Barwick, V., Duguid Farrant, T. (2009). Practical statistics for the analytical scientist, a bench guide. 2nd Edition. RSC Publishing.

How to cite this Applications note:
Fraser, A.W. (2020). Level of significance and confidence and Type 1 and 2 errors. 2 pages.